On the Quantity of the precession of the Equinoxes, as determined by certain Stars that appear to have no proper motion. *By* The President.

Read January 17, 1825.

THE observations of astronomers during the last half century have shewn that a multitude of stars, which had usually been considered fixed, are not really so. They exhibit a regular change of place, very perceptible in the course of a few years; which, with respect to any one star, arises either from the motion of our own system, or from the motion of the star, or from the combined motion of each system. In different stars the directions of these motions are so various, that little hope can be entertained of developing the motion of our own system, or of ascertaining whether, with respect to any one star, it be at all sensible.

These apparent motions, although, when contemplated in conjunction with the immeasurable distances of the bodies, they afford us most sublime views of the creation, are in some degree inconvenient to the astronomer.

In referring any motions in our system to a fixed star, it was formerly supposed we referred to a permanent point; now we find it not easy to separate the motion of the star from the motion to be investigated. Thus, in the important matter of the quantity of precession of the equinoxes, it was thought only necessary to compare the distances of a star in the ecliptic from the equinoctial point at two distant periods. The motions now ascertained to belong to so many stars render entirely unsafe this mode of proceed-

ing. Accordingly Mr. Bessel, in his elaborate investigation of the quantity of precession, (Astron. Fundament.) has considered it necessary to use more than 2000 stars, distributed in all parts of the heavens, concluding that the proper motions in opposite directions would compensate for each other, and an exact result be obtained.

Under these circumstances, it evidently is desirable to ascertain with certainty, or by a high degree of probability, any stars that may be fixed, that is devoid of a sensible proper motion.

The numerous double stars, many of which Sir Wm. Herschel observed upwards of forty years ago, appeared to me likely to furnish some information in this respect. The Pole Star particularly occurred for this enquiry. The Pole Star is of the second magnitude; and is, as is well known, attended by a small star of the tenth or eleventh magnitude, only to be seen by good telescopes. The distance between these two stars is 18″,7.

Now one hypothesis is, that the smaller star may have no relation to the larger, except being seen in nearly the same direction, and may perhaps be much more distant from us. Another hypothesis is, that the two stars may be both mutually attracted, and have a relative motion with respect to each other. In submitting these hypotheses to observation, we find that the smaller star appears to remain at the same distance from the larger one that it was forty years ago, when observed by Sir William Herschel. We are not certain that any change of distance has taken place, and also the angle of position of the two stars remains the same within the limits of exact observation. The smaller star precedes the larger, and the angle of position is about 60° S.

This permanency of distance and of the angle of position makes it probable, that these stars are too remote from each other to be

connected by mutual attraction; and further, that neither of these stars have any visible proper motion, as it is very unlikely that they should both have exactly the same proper motion.

Now among the numerous double stars there are several other pairs that seem not to have changed their position relatively to each other. For instance, ζ Ursæ Majoris and its attendant have preserved the same relative positions. Such stars, therefore, probably have no proper motions. This conjecture appeared to me nearly if not altogether confirmed, when on examination I found that the distance between the Pole Star and ζ Ursæ Majoris remains by my latest observations the same that it was found by Bradley in 1755, and by Piazzi in 1800.

Distance between α Polaris and ζ Ursæ Majoris,

By Greenwich Ob. 1755	-	35°46′ 37″,7
Palermo Ob. 1800	- -	37,4
Ob. T. C. Dublin, 1824	- -	38,5

ζ Ursæ Majoris being nearly opposite in right ascension to Polaris, this distance does not depend on any accurate determination of the right ascensions, but only on the accurate determination of the polar distances. The right ascensions of Dr. Bradley have not been observed with equal accuracy as the declinations, except perhaps for about fourteen stars.

Pursuing this enquiry as to other stars, several were found that appeared to me fixed. Wherever I found two stars of nearly the same right ascension remaining at the same distance from each other, I have suspected that both were altogether or nearly fixed. In this way I was led to conjecture that α Cassiopeæ, Rigel, β Aurigæ, α Orionis, α Cygni, and β Cephei, and several others, have had no sensible proper motion for nearly seventy years.

For α Cassiopeæ, β Aurigæ, and β Cephei, Bradley's observations were not sufficiently numerous to enable me to venture to decide on the question as to them. But fortunately the observations in declinations of Rigel, α Orionis, and α Cygni, are very numerous; and these stars are three of the fourteen of which the right ascensions have been computed from Dr. Bradley's observations by Mr. Bessel, with great skill and labour. The distances of these stars from each other in 1755, 1800, and 1824, seem to leave no doubt that they have been, with respect to the interval of seventy years, really fixed.

DISTANCES.

	Rigel and α Cygni.	α Orionis and α Cygni.	Rigel and α Orionis.
	° ′ ″	° ′ ″	° ′ ″
1755 Greenwich,	122 11 35,6	115.29 49,8	18 36 15,7
1800 Palermo,	36,8	49,6	17,4
1824 Dublin	36,8	48,1	16,2

The distances of the Pole Star from these three stars respectively, might at first lead us to suppose, that although the Pole Star may have no proper motion in declination, it has a small proper motion in right ascension; but I am inclined, for the present, to attribute the small differences to an inexactness in the right ascension of the Pole Star. Of the three stars, there can be no doubt as to their permanency of position, and on this account they will, I imagine, be considered worthy of the future notice of astronomers.

By comparing the polar distance of the Pole Star in 1755 with that in 1819, as given by me in Phil. Trans. 1822, we obtain the

luni-solar precession $=50'',38$. The polar distance of the Pole Star from the vicinity of the star to the Pole, admits of being determined with great exactness, perhaps more so than that of any other star. Uncertainty in the constant of refraction will not sensibly affect the the result; and as the arch measured is small, the result is less liable to be affected by errors of division.

The comparison of the computed with the observed places of this star by several astronomers hereafter given, tend to shew the exactness of observation.

The Duke of Marlborough's observations in 1790, M. Piazzi in 1800, and the others adduced, appear to confirm the exactness of Bradley's polar distance in 1755. So that if the nonexistence of proper motion in declination be allowed, the quantity $50'',38$ for luni-solar precession in 1788 is very exact.

The stars Rigel and α Orionis are well situate for deducing by the changes in right ascension the quantity of the general precession; and thence by comparing it with the luni-solar, we obtain the displacement of the ecliptic on the equator. The position of α Cygni is not so favorable. The mean result, from the three, gives the motion in sixty-six years of the ecliptic on the equator $= 12'', 1$.

The quantity of precession thus found is considerably greater than that adopted by M. Delambre, and greater than that adopted by Mr. Bessel. But it is remarkable that Mr. Bessel's result from the *declinations* of above 2000 stars agrees very nearly with what the Pole Star gives as above. M. Piazzi also has adopted very nearly the same quantity as has been found by the Pole Star.

PRECESSION BY POLE STAR, &c.

As preparatory to the computations to be made, the places of the following stars are here given for **1755** and **1821.**

	1755.		1821.	
	AR.	N. P. D.	AR.	N. P. D.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Polaris,	10 55 34,4	2 0 18,9	14 19 27,6	1 38 46,2
ζ Ursæ Maj.	198 30 6,8	33 47 18,7	199 10 30	34 8 12,5
Rigel,	75 41 36,6	98 30 15,9	76 29 3,60	98 24 57,4
α Orionis,	85 28 43,0	82 39 41,7	86 22 12,90	82 38 6,6
α Cygni,	308 16 18,9	45 35 3,3	308 49 56,25	45 21 17,1

THE POSITION OF THE SMALL STAR NEAR POLARIS.

	POSITION.		DISTANCE.	
	° ′		″	
In 1781,5	67.2	S. preceding.	18,45	Dr. Herschell.
1802	61.43	S. p.	. . .	
1815	60.2	S. p.	18,50	Struve.
1819	60.6	S. p.	18,05	Do.
1822	. . . .		18,26	Do.
1823	61.11	S. p.	18,70	Mess. Herschell and South.
1825	61.18	S. p.	18,18	Observatory Dublin.

These results, if we except the first angle of position, appear to shew that these stars have had no relative motion; and the first angle of position is reduced by the effect of precession in forty-two years to 64° 46′, as Mr. Herschel has remarked, which therefore cannot be considered as affecting the conclusion.

THE POSITIONS OF THE SMALL STAR NEAR ζ URSA MAJORIS.

	POSITION.	DISTANCE.	
	° ′	″	
1755	53 5 S. following.	13,9	Bradley, according to Struve.
1780	56 4 S. f.	14,5	Sir William Herschel.
1800	56 1 S. f.	16,10	Piazzi.
1802	51 14 S. f.	15,4	Sir William Herschel and Triesnecker.
1819	55 20 S. f.	14,2	Struve.
1822	58 12 S. f.	14,7	Do.
1822	57 46 S. f.	14,45	Herschel and South.
1825	52 10 S. f.	14,83	By diff. AR. and ZD. Dublin Instruments.

These results appear to prove, that these stars have had no relative motion during the last fifty or sixty years.

Assuming then that the change in the polar distance of the Pole Star, between 1755 and 1821 has arisen entirely from the luni-solar precession, we can compute the quantity of the luni-solar precession in longitude is as follows: D, L, l and O representing the declination, longitude and latitude of the Pole Star and obliquity of the ecliptic in 1755, and ΔL and ΔD, representing the luni-solar variation of longitude and variation of declination between 1755 and 1821,

$$\sin. D = \cos O \sin l + \sin O \cos l \sin. L,$$
$$\sin. (D + \Delta D) = \cos. O \sin. l + \sin O \cos. l \sin (L + \Delta D),$$

whence

$$\sin. \tfrac{1}{2} \Delta L = \frac{\sin. \frac{1}{2} \Delta D \cos. (D + \frac{1}{2} \Delta D)}{\cos. l \sin. O \cos. (L + \frac{1}{2} \Delta D)}.$$

From the preceding place of the Pole Star in 1755, and the obliquity of the ecliptic $=23° \; 28' \; 15'',3$, we deduce

$L = 85^\circ\, 8'\, 26'',3$; $l = 66^\circ\, 42'\, 20'',8$, also $\Delta D' = 21'\, 32'',7$.

Hence the above formula gives

$$\Delta L = 55'\, 25'',13, \text{ or if}$$
$$\Delta D = 21\ 32,7 + u,$$
$$\Delta L = 55\ 25,13 + 2,30\ u.$$

u may represent the error, if any, occasioned both by supposing the Pole Star without proper motion in declination, and by supposing the declinations in 1755 and 1821 exact. It is probable, from the extreme exactness with which the declination of the Pole Star can be obtained, that as far as the latter source of error is concerned u does not exceed a fraction of a second. This will appear more evident when we compare the declinations obtained by computation from those in 1755 and 1821 with the observed.

The above value of ΔL gives the annual luni-solar precession in longitude $= 50'',381 + ,035\ u$. Therefore the formula for luni-solar precession in NPD, in 1788, of any star

$$= \left.\begin{matrix} -20,063 \\ -\ 0,014\ u \end{matrix}\right\} \cos.\ AR.$$

To obtain the declination of the Pole Star at any time, it is convenient on account of its proximity to the Pole to have recourse to the formula

$$\sin. \tfrac{1}{2} \Delta D = \frac{\sin. \frac{1}{2} \Delta L. \cos. l.\ \sin O. \cos. (L + \frac{1}{2} \Delta L)}{\cos. (D + \frac{1}{2} \Delta D)},$$

or in the present position of the Pole Star

$$\Delta D = \frac{\Delta L, \cos. l \sin O \cos. L}{\cos. D} - r,$$

r being a small correction, which may, for one hundred years posterior to 1755, be taken from the following

TABLE.

By the above formulæ for any year, $1755 + n$

$$\log.(\triangle D + r) = \log. n + 1.294510.$$

Example. To find the mean declination of the Pole Star, January 1, 1800,

$$\log.(\triangle D + r) = 2.91772 = \log. 886'',6,$$

or

$$\begin{array}{lr} & '' \quad\quad ' \quad '' \\ \triangle D = 886,6 - 3,8 = & 14 \;\; 43,3 \\ \text{Declination, 1755} \quad . \quad . & 87 \;\; 59 \;\; 41,1 \\ \hline \text{Declination, January 1, 1800,} & 88 \;\; 14 \;\; 24,4 \end{array}$$

	r
1755	0,00
65	0,12
75	0,58
85	1,38
95	2,52
1805	4,16
15	6,10
25	8,66
35	11,72
45	15,26
1825	19,68

The following comparisons shew the differences between the observed and computed declinations. The computed declinations are those deduced in the above manner from the Greenwich declinations in 1755, and Dublin, 1821 :

		Declination observed.	Declination computed.	Diff.
		° ′ ″	° ′ ″	″
1790	Duke of Marlborough,	88 11 8,7	88 11 8,7	0,0
1796	Delambre,	88 13 7,3	88 13 6,2	— 1,2
1800	Piazzi,	88 14 24,3	88 14 24,4	+ 0,1
1804	De Zach,	88 15 43,8	88 15 42,5	— 1,3
1807	Groombridge,	88 16 41,2	88 16 41,0	— 0,2
1809	Ob. Dublin,	88 17 20,1	88 17 20,5	+ 0,4
1810	De Zach,	88 17 39,7	88 17 40,1	+ 0,4
1811	Oriani,	88 17 59,5	88 17 59,6	+ 0,1
1812	Arago and Matthieu,	88 18 19,0	88 18 19,0	0,0
1813	Greenwich,	88 18 38,3	88 18 38,6	+ 0,3
	Dublin,	88 18 38,2		+ 0,4
1817	Littrow,	88 18 55,3	88 19 55,9	+ 0,6
1825	Pearson,	88 22 31,1		+ 0,4
	Greenwich,	88 22 31,1	88 22 31,5	+ 0,4
	Dublin (Kater's Collimator)	88 22 31,6		— 0,1

The preceding table proves most satisfactorily the regular motion of the Pole Star in declination between 1755 and 1825, and also the extreme degree of exactness of the determinations of the declination by observation. Therefore, as far as observation is concerned, the latter part of the value of the luni-solar precession above determined, viz. 50,″381 + 0,035 u is probably very small. That it is also insensible from proper motion in declination, is likely from the unchangeableness of the relative positions of Polaris and its attendant. Hence 50″,381 may be considered a very near determination of the luni-solar precession in 1788.

		N.P.D. ζ Ursæ Maj.	N P.D. Polaris.	Diff. AR
		° ′ ″	° ′ ″	° ′
By Greenwich Obser.	1755	34 47 18,7	2 0 18,9	172 25
Palermo, .	1800	34 1 34,2	1 45 35,7	173 9
Dublin, .	1821	34 8 12,5	1 38 46,2	175 9

These stars being nearly opposite in right ascension, much precision is not required in the diff. of right ascensions for investigating the distances between these stars at the respective periods.

With the above data

		° ′ ″
The distance in	1755 =	35 46 37,6
	1804	35 46 37,6
	1821	35 46 38,2

The near agreement of these distances in itself renders it highly probable that both the Pole Star and ζ Ursæ Majoris have no sensible proper motion. This is much strengthened when we consider that the attendant of ζ Ursæ Majoris has preserved its relative position to the larger star during the last forty years, in like manner as the attendant of Polaris has preserved its position to Polaris.

M. Struve, however, attributed a motion in right ascension to this star, which probably arises from an inexactness in one of the right ascensions which he used.

From the right ascensions and declinations of Rigel, α Orionis, and α Cygni above given, were deduced the distances of these stars from each other as before given. As an addition to the argument thence deduced for the fixedness of these stars we may adduce the observed and computed N. P. distances at different periods. On account of the smallness of the cosines of the right ascensions of Rigel and α Orionis, the computed precessions in north polar distances cannot be affected by any possible error in the quantity of luni-solar precession, as deduced above from the Pole Star. The

argument is not quite so strong with respect to α Cygni. The computed N. P. distances are deduced from Bradley's N. P. distances in 1755.

	Ob. Palermo, 1800.	Computed 1800.	Ob. Dublin, 1821.	Computed 1821.
	° ′ ″	″	° ′ ″	″
Rigel,	98 26 36,4	36,9	98 24 57,4	57,5
α Orionis,	82 38 35,0	35,3	82 38 6,6	7,6
α Cygni,	45 25 40,2	41,6	45 21 17,1	17,9

The above agreement of the computed and observed places affords matter for considerations not immediately connected with our present enquiry. The circumstances relative to the exactness of the instruments and observations that have produced such coincidences are worth being investigated, and may perhaps be the subject of a future communication.

Assuming Rigel, α Orionis, and Sirius without proper motion, we may deduce the motion of the ecliptic on the equator.

Let da represent the motion of the ecliptic on the equator between 1755 and 1821. Then with the right ascensions and north polar distances, and obliquity of the ecliptic in 1755, $=23° 28' 15''2$, we obtain as follows:

FOR RIGEL.

	AR.	N. P. D.	Longitudes.
	° ′ ″	° ′ ″	° ′ ″
1755	75 41 36,6	98 30 15,9	73 24 23,9
1821	76 29 3,6 $+da$	98 84 57,4	74 19 35,2 $+ 1,15da$

Hence the luni-solar precession in longitude in 66 years

$$= 55'\ 11'',3 + 1,15\ da$$

$$\text{By the Pole Star} = 55\ 25,1 + 2,30\ du$$

whence is deduced

$$da = 12'',2 + 2,0\ du$$

FOR *a* ORIONIS.

	AR. ° ′ ″	N.P.D. ° ′ ″	Long. ° ′ ″
1755	85 28 43,0	82 38 20,1	85 19 59,6
1821	86 22 12,9+*da*	82 37 13,9	86 15 13,9+1,03 *da*

$$\text{Or the luni-solar precession} = 55'\ 14'',3 + 1,03\ da$$

$$\text{By the Pole Star} \quad . \quad = 55\ 25,1 + 2,30\ du.$$

$$\text{Hence } da = 10'',5 + 2,2\ du.$$

FOR *a* CYGNI.

	AR. ° ′ ″	N. P. D. ° ′ ″	Long. ° ′ ″
1755	308 16 18,9	45 35 3,3	61 57 38,6
1121	308 49 56,2 + *da*	45 21 17,1	62 52 47,2+1,21 *da*

$$\text{Or the luni-solar precession} = 55'\ 8'',6 + 1,21\ da$$

$$\text{By the Pole Star} \quad . \quad = 55\ 25,1 + 2,30\ du$$

$$\text{Hence } da = 13'',6 + 1,9\ du.$$

The mean of these three determinations $= 12'',1 + 2,0\ du$. The secular motion therefore $= 18'',3 + 3,0\ du$. If we suppose the Pole Star without proper motion in declination, this quantity $= 18'',3$, and the motion on the ecliptic $= 18'',3$ cos. ob. $= 16'',8$. Mr. Bessel's determination is $14'',9$.* The exactness of this quantity however depends on the absolute right ascensions in 1755 and 1821, which

* Astr. Fund. p. 297.

are necessarily more uncertain than the elements from which the angular distances of the stars Rigel, α Orionis, and α Cygni have been determined in 1755, 1800 and 1821.

From the above determination, supposing the Pole Star without proper motion,

The annual luni-solar precession in longitude for 1788 = $50'',38$
And the annual general precession . . . . = $50, 21$.

APPENDIX

To a former Paper, on the quantity of the precession of the Equinoxes, as determined by certain Stars that appear to have no proper motion. By The President.

Read May 22, 1826.

SINCE my preceding paper, relative to the quantity of the precession of the Equinoxes as determined by certain stars that appear to have no proper motion, was read before the Academy, additional observations have been made at our Observatory, which may be considered as affording further information of some importance.

Dr. Maskelyne, in order to determine with the utmost exactness the apparent annual motion in right ascension of his fundamental Star α Aquilæ, compared its place at different periods with certain of the adjacent small Stars. On the supposition that these small Stars had no sensible proper motion, he was enabled to ascertain the proper motion of α Aquilæ. From what we now know relative to the fixed Stars, this hypothesis appears to rest on a very slight foundation. The Stars he used were of the 6th and 7th magnitudes, and there are, as is well known, two Stars of the 6th magnitude (1 and 2. 61 Cygni) of which the proper motions far exceed those of any other Stars. The proper motion of 40 α Eridani only of the 5th magnitude, is next in quantity to those of the Stars of Cygni, 61 Virginis of the 4. 5 mag.—43 Comæ Beren. of the 5 mag. 61 Draconis of the 5 mag. have all very considerable proper

motions.—I was therefore led to expect that on comparing the places of the small Stars of Aquilæ with α Aquilæ, I should find changes had taken place both as to the position of the Stars in respect to α Aquilæ, and with respect to each other.—The observations were made last Autumn. The differences of right ascensions and of North polar distances of four small Stars, and of α Aquilæ which had been observed by Dr. Maskelyne in 1765, were ascertained. On reducing the observations, the results were found different from what I had expected. I found that the four small Stars preserved exactly the same positions with respect to each other as resulted from Dr. Maskelyne's observations in 1765. It follows therefore, that these four Stars, considerably distant from each other, have not perceptibly moved during the last seventy years, or have moved in the same direction, and with a common velocity. The latter supposition is very improbable when considered with a reference to α Aquilæ, whose relative position to these Stars is very considerably changed. Taking these stars as fixed, the proper motion of α Aquilæ is thereby ascertained with considerable precision.

I have also, by the observations of small Stars near α Cygni, been enabled to derive an independent proof of the fixedness of that Star. Among the Stars observed by Dr. Bradley, and of which the mean places are given for 1755 in the Astronom. fundamenta, are three small Stars so near α Cygni that we may reasonably rely that the differences of the right ascensions and declinations of them and α Cygni were correctly taken.—These stars have during the last Autumn been again compared. It will be considered a curious circumstance, that less than ten degrees from an apparently immoveable group of Stars (one of them (α Cygni) of the first or second magnitude,) there are two Stars of the sixth magnitude that,

in the space of seventy years have moved upwards of five minutes of space.

The extreme irregularity of the proper motion of the Stars as far as situation and magnitude are concerned, may be remarked in all parts of the Heavens, but it is particularly deserving of notice with respect to the Stars near α Aquilæ. The Star γ Aquilæ of 2.3 magnitude, appears to have none or a very small proper motion. The four small Stars of the 6th and 7th magnitudes recently observed also appear fixed, while α Aquilæ has a secular motion of 50″ in right ascension, and 40″ in declination. The Star β Aquilæ, now only of the third magnitude has only a very small motion in right ascension, but in declination it has a secular motion of about 43″ *receding* from the Pole by this quantity, while α Aquilæ *approaches* the Pole by nearly an equal quantity. Again, according to the observations of Messrs. Herschel and South compared with those of Sir William Herschel, a Star of the 10th magnitude distant from α Aquilæ only about $2\frac{1}{2}$ minutes, moves more rapidly than α, but in nearly the same direction. The exactness of the determination of the proper motion of α Aquilæ itself is now beyond all doubt. The present observations have confirmed the former conclusions of Maskelyne and Piazzi.

On more closely examining the right ascensions of the Pole Star, as deduced at different periods by several Astronomers, and more particularly those deduced by Mr. Bessel from Dr. Bradley's observations, I have satisfied myself that my former arguments for shewing that this Star has been without proper motion for many years past, are not sufficient.—The discordances of the observed and computed right ascensions cannot be attributed wholly to the errors of observation. This materially alters several of the con-

clusions I had deduced, and it becomes of importance to endeavour to investigate more minutely the existence or non-existence of proper motion in this Star. Assuming the fixedness of the three Stars, Rigel, α Orionis and α Cygni, we may investigate the proper motion of Polaris (if any) and that without any knowledge of the precession of the Equinoxes.

We may conceive a spherical triangle formed by Polaris in 1755, Rigel and α Cygni, and another formed by the Pole in 1821, Rigel and α Cygni.—We can compute the distance of the vertices of these triangles, or the distance of the *place* of the Pole Star in 1755 from the Pole in 1821, and comparing this distance with the observed polar distance of the Pole Star in 1821, we have the proper motion of the Pole Star in polar distance, and also by a small additional computation, the proper motion in right ascension. We may instead of Rigel use α Orionis. Also instead of α Cygni we may use α Aquilæ, if we correct for its proper motion, and then use it as a fixed Star. Thus, we have four determinations:—the mean of the four gives $3'',5$ for the proper motion of the Polar Star in declination, by which quantity it has increased its distance from the Pole in 66 years.—This is much greater than could have been expected under the circumstances that have been previously stated, and makes a considerable change in the former conclusion respecting the luni-solar precession. It was therefore desirable to enquire into the accuracy of the result, by as many independent operations as possible.

The variation of the declination of the Stars near the Equinoctial Colure, provided they were without proper motion, would separately give with exactness the quantity of luni-solar precession, by comparing the N. P. distances in 1755 and 1821. But as several of them have considerable proper motions, it is necessary to investigate it for each, previously to applying them to investigate the luni-solar precession.

The quantity of proper motion for each of these Stars may be separately investigated by means of the three fixed Stars Rigel, α Orionis and α Cygni.—Taking the distances between Rigel and α Cygni for the common base of two spherical triangles, the vertices of which are the places of the Star in 1755 and 1821.—The distance between these vertices is the whole proper motion of the Star in 66 years. The part of this motion in N. P. dist. being applied to the whole change of North Polar distance, gives the change by precession in that time. Hence, the annual luni-solar precession for each of these Stars is obtained. The near agreement of these results for each Star as exhibited in the Table hereafter given, will shew the degree of confidence that may be placed in them.—The precession separately determined for each Star enables us to deduce the proper motion of the Pole Star by comparing the observed change of N. P. distance with the computed. The mean of 13 results gives the proper motion of the Pole Star in declination $= 3'',2$. The near agreement of the quantity of proper motion of the Pole Star in N. P. distance in 66 years, as determined by these different processes, appears to establish the accuracy of the result.

The proper motion in N. P. distance being taken $= + 3'',3$, the luni-solar precession in Longitude in 1788 $= 50'',50$. This quantity considerably exceeds that determined by Mr. Bessel, but the steps by which it has been deduced appear to me to render it certain that it cannot be in error more than $\frac{1}{20}$ of a second. This increase of the luni-solar precession will not affect the quantity of general precession, which will be $50'',22$ nearly as before, but the direct motion of the ecliptic on the equator will be greatly increased, so much so as, according to our present knowledge, to appear incompatible with the result deduced by Physical Astronomy. The accuracy of the general precession as deduced from observation, depending on the

absolute quantity of the right ascensions at the two periods, cannot be so much depended on as the luni-solar precession determined as above, and on this account the quantity of direct motion of the ecliptic on the equator will not appear entitled to equal confidence. This quantity is 18″,68 in 66 years, and must be left for future inquiry.

It will not, I conceive, be considered that the former conclusion respecting the Pole Star was founded on slight circumstances.— The relative permanency of the position of it and the small Star, and the constant interval between the Pole Star and ζ Ursæ Majoris appeared to fully justify the deduction that was made, especially when it is considered that the relative position of ζ Ursæ Maj. and its *comes* has remained the same. It required therefore very strong evidence to shew the contrary. This evidence has been, I think it will be allowed, obtained in deducing from the several Stars near the equinoctial colure, nearly the same quantity of proper motion in declination for the Pole Star, and the same as that deduced by the Pole Star itself by help of α Cygni, Rigel and α Orionis. It may indeed be objected, that the three Stars α Cygni, Rigel and α Orionis are not fixed, but have all the same quantity of proper motion in parallel directions. However, if all the circumstances connected with the fixedness of these Stars be considered, such a supposition is in itself highly improbable, and the contrary appears to be put beyond all doubt by the comparison of α Cygni with the small Stars near it.

Since the former paper was read, *a Catalogue of right ascensions of the principal Stars has been completed from observations made at

* This catalogue in R. Ascension, and that in N. P. D. determined by the circle both reduced to 1825 are hereafter given, as they have been used in all the computations.

the College Observatory with the eight feet Circle and Transit Instrument. The equinoxes observed were those commencing Autumn 1822, and ending Spring 1825. It is believed these right ascensions have been determined with considerable exactness. They have therefore been applied to investigate, by help of the quantities of annual precession as now found, the proper motions in right ascension of the principal fixed Stars. The catalogue in North polar distance formed by observations with the eight feet Circle, has also been used for finding the proper motions in North polar distance. There is reason to expect that these proper motions will be found hereafter more exact than any which have hitherto been given.

It may be right to mention, that in forming the catalogue of right ascensions, the constant of aberration was taken $=20'',36$, and that of nutation $= 9''25$, as I had found by former observations and investigations.

This Catalogue in right ascension differs so much from the Catalogue in right ascension as given in the Nautical Almanacs for 1827 and 1828, that it appears necessary to notice this circumstance. In some of the Stars the difference amounts to $\frac{4}{10}$ of a second of time, or $6''$ in space. The determination of the absolute right ascension of a Star is certainly a very delicate investigation, but still with the present improved means of observing it was not to be expected so great a difference would be found. It is an object of interest to ascertain which determination is nearer the truth. M. Bessel's recent Catalogue (Astronomische Nachrichten, No. 78,) is between the two, but somewhat nearer to mine. I can only refer to the small mean errors of my Catalogue in each of the three years, which tend to establish its exactness.—There appears no cause whence a constant error should arise, unless from the different degrees of temperature at the Vernal and Autumnal Equinoxes, and

the effect of this can be but small. The effect however from this cause must be somewhat greater in the Greenwich Catalogue, because the observations made there are reduced by Bradley's Formula of Refraction, in which the allowance for change of temperature is not conformable to experiment. On the other hand, taking the place of the equinox as in the Greenwich Cat. the quantity of the motion of the ecliptic on the equator will be much reduced, which circumstance is greatly in favour of the R. ascensions of that Catalogue. By adopting the computations of Mr. Bessel on Bradley's observations we are enabled to compare my Catalogue in right ascension with the Catalogues of Maskelyne in 1770 and in 1805, and of Piazzi in 1800. The result is very encouraging, because it appears to prove that the places of the principal fixed Stars have been determined at different periods during the last sixty years with considerable exactness, and consequently we may expect to be able sooner to avail ourselves of future observations in investigating several points of importance relative to the fixed Stars.

The Catalogue of Dr. Maskelyne of 1770 differs from mine, reduced to 1770 in its mean quantity only by 0″,07 in time in right ascension, and by 0,″17 in North Polar distance.

The Catalogue of Piazzi of 1800 differs from mine only in its mean quantity by 0″,04 in right ascension, and by 0″,16 in N. Polar dist.

The Cat. of Maskelyne of 1805 differs from mine in its mean quantity by 0″,04 in right ascension.

The close agreement of the respective Stars of the Cat. of 1805 in right ascension with mine is particularly deserving of notice, and it ought I think to be kept in mind, that this Catalogue of Dr. Maskelyne was made only a few years before his death with the old Transit Instrument and the *Mural Quadrant* of the Observatory at Greenwich.

RESULTS OF OBSERVATIONS AND COMPUTATIONS.

STARS NEAR α AQUILÆ.

GREENWICH, 1765. DUBLIN, 1825.

α Aquilæ and	Diff. R. A.	No. of Obser.	Diff. N.P.D.	No. of Obser.	α Aquilæ and	Diff. R. A.	No. of Obser.	Diff. N.P.D.	No. of Obser.
	′ ″		′ ″			′ ″		′ ″	
1 * p	7 54,61	13	25 24,71	12	1 * p	7 56,38	6	26 21,50	6
2 * p	5 57,92	8	5 5,92	12	2 * p	5 59,93	7	5 57,92	6
3 * f	6 13,23	8	25 34,94	9	3 * f	6 11,80	7	25 28,07	6
4 * f	10 17,79	11	20 11,04	14	4 * f	10 16,36	7	19 45,70	6

All the small stars are to the southward of α Aquilæ. From these are deduced the sides* of the triangle formed by the stars 1, 3, 4,

	1765.	1825.
	° ′ ″	° ′ ″
1 and 4	4 30 33,80	4 30 34,94
1 and 3	3 29 58,60	3 30 0,20
3 and 4	1 0 48,08	1 0 47,58

The sides of the triangle formed by the stars 1, 2, 3,

	1765.	1825.
	° ′ ″	° ′ ″
1 and 3	3 29 58,60	3 30 0,20
1 and 2	0 35 18,80	0 35 18,60
2 and 3	3 2 9,24	0 2 8,70

* These sides are computed by the following formulæ:
$N.n$ being the polar distances, and P the angle at the pole, or the diff. of right ascensions—
sin. $\frac{1}{2}$ dist. $=$ sin. $\frac{1}{2}$ $P \times \sqrt{\text{sin. } N \text{ sin. } n} \times$ sec. A.

$$\tan. A = \frac{\sin. \frac{1}{2}(N - n)}{\sin. \frac{1}{2} P \sin. N \sin. n}.$$

It is evident from a comparison of these numbers that the four stars have preserved (within the limits of the errors of observation) the same relative positions to each other. Hence we may infer, that the proper motion of each has been imperceptible during that time. Therefore the diff. of right ascension and N. P. D. for 1765, above given, being corrected for diff. of precession between 1765 and 1825, and then compared with the difference for 1825, the proper motion of α Aquilæ in R. A. and N. P. D. is obtained from each star as in the following

TABLE.

α Aquilæ and	Diff. R. Asc. reduced to 1825.	Ob. Diff. in 1825.	P. Mot. in R. A. in 60 years.	Diff. N.P.D. reduced to 1825.	Ob. diff. in 1825.	P. M. in N. P. dist. in 60 years.
	′ ″	″	″	′ ″	′ ″	″
1 * *p*	7 54,23	56,31	+ 2,08	26 2,69	26 21,57	— 18,88
2 * *p*	5 57,94	59,87	1,93	5 34,78	5 58,03	23,25
3 * *f*	6 13,90	11,97	1,93	25 5,66	25 27,87	22,21
4 * *f*	10 18,44	18,39	2,05	19 22,80	19 45,93	23,13
		mean	1,99		mean	— 21,87
			″			
		or in space	29,85			

STARS NEAR α CYGNI.

α Cygni and	1755. Diff. R. A.	1755. Diff. N.P.D.	1825. Diff. R.A.	1825. Diff. N.P.D.
	° ′ ″	′ ″	° ′ ″	′ ″
49 Cygni *n. p.*	0 29 20,3	23 45,2	0 29 45,1	23 36,5
55 —— *n. f.*	1 52 38,5	47 58,8	1 52 39,3	48 35,4
57 —— *s. f.*	2 52 32,3	56 44,6	2 53 54,4	55 46,9

From these are deduced the sides of the triangle formed by 49, α, and 55 Cygni.

	1755.	1825.
	° ′ ″	° ′ ″
49 and α	0 31 37,7	0 31 39,3
55 and α	1 33 12,0	1 33 13,0
49 and 55	1 43 15,0	1 43 17,0

The sides of the triangle formed by α, 55 and 57.

	1755.	1825.
	° ′ ″	° ′ ″
57 and α	2 16 34,1	2 16 34,0
55 and α	1 33 12,0	1 33 13,0
55 and 57	1 53 8,6	1 53 7,0

Hence it is evident that 49, α, 55 and 57 Cygni have preserved, within the errors of observation, the same relative positions for the last 70 years.

	Distances of the place of Polaris in 1755 from the Pole in 1821.	R. ascension in 1821 of the place of Polaris in 1755.
	° ′ ″	° ′ ″
By α Cygni and Rigel	1 38 45,0	14 17 34,6
α Cygni and α Orionis	43,9	17 19,3
α Aquilæ and Rigel	42,5	18 0,9
α Aquilæ and α Orionis	39,3	18 9,9
mean	1 38 42,7	14 17 43,9
Observed pol. dist. of Polaris, 1821	1 38 46,2	Ob. 14 19 27,6
Proper motion in 66 years	3,5	1 43,7 or 3″,3 in a great circle.

A Catalogue, in right ascension and north polar distance of forty-eight principal stars.

	AR. 1825.	Ann. Var. 1824.	Secular Var.	N. P. D. 1825.	Ann. Var. 1824.	Secular Var.
	h ′ ″	″	″	° ′ ″	″	″
γ Pegasi	0 4 13,91	+ 3,077	+ 0,010	75 47 20,20	− 20,076	+ 0,013
α Cassiopeæ	0 30 37,85	3,333	0,051	34 25 24,36	19,862	0,067
Polaris	0 58 17,10	15,000		1 37 28,36	19,460	
α Arietis	1 57 19,52	3,354	0,020	67 22 9,00	17,368	0,240
α Ceti	2 53 8,26	3,120	0,010	86 36 7,18	14,517	0,316
α Persei	3 11 52,30	4,221	0,049	40 46 11,10	13,403	0,456
Aldebaran	4 25 53,12	3,427	0,011	73 51 1,91	7,862	0,458
Capella	5 3 46,31	4,411	0,019	44 11 27,22	4,470	0,622
Rigel	5 6 7,75	2,877	0,004	98 24 38,75	4,665	0,411
β Tauri	5 15 13,97	3,781	0,009	61 32 59,26	3,717	0,540
α Orionis	5 45 41,83	3,243	+ 0,003	82 38 1,45	− 1,271	0,473
Sirius	6 37 25,96	2,643	0,000	106 28 57,37	+ 4,467	0,380
Castor	7 23 25,07	3,847	− 0,012	57 44 13,16	7,189	0,527
Procyon	7 30 8,08	3,146	0,004	84 20 0,47	8,712	0,422
Pollux	7 34 35,56	3,684	0,012	61 33 33,35	8,083	0,491
α Hydræ	9 18 59,15	2,948	0,001	97 54 14,68	15,246	0,273
Regulus	9 59 2,41	3,204	0,010	77 10 51,29	17,295	0,233
β Ursæ Maj.				32 40 54,35	19,132	0,160
α ———	10 52 50,65	3,801	0,086	27 18 22,55	19,282	0,160
β Leonis	11 40 7,47	3,065	0,008	74 26 58,01	20,051	0,036
γ Ursæ Maj.	11 44 34,79	3,208	0,046	35 19 55,16	20,003	+ 0,029
ε ———	12 46 17,78	2,670	− 0,029	33 5 17,62	19,695	− 0,084
Spica-Virginis	13 15 58,93	3,143	+ 0,011	100 14 39,99	18,980	0,153
ζ Ursæ Maj.				34 9 28,33	18,953	0,122
η ———	13 40 37,95	2,377	− 0,011	39 48 36,22	18,164	0,153
Arcturus	14 7 40,77	2,730	+ 0,001	69 54 7,53	18,971	0,216
1 α Libræ	14 41 1,20	3,297	0,016			
2 α Libræ	14 41 12,61	+ 3,300	0,016	105 18 28,97	15,316	− 0,313
β Ursæ Min.	14 51 18,91	− 0,301	0,111	15 7 46,27	14,767	+ 0,029
α Cor. bor.	15 27 16,68	+ 2,534	0,002	62 41 25,13	12,431	− 0,295
α Serpentis	15 35 39,09	2,947	0,006	83 1 0,09	11,719	0,349
Antares	16 18 41,33	3,658	0,015	116 2 1,20	8,551	0,484
α Herculis	17 6 40,17	2,729	0,004	75 24 9,65	4,554	0,387
α Ophinchi	17 26 48,74	2,775	0,003	77 18 16,67	3,062	0,400
γ Draconis	17 52 32,61	1,390	0,004	38 29 11,61	+ 0,677	0,202
α Lyræ	18 31 0,73	2,028	+ 0,002	51 22 24,82	− 3,010	0,291
γ Aquilæ	19 37 56,22	+ 2,853	− 0,001	79 48 21,21	8,349	0,376
α Aquilæ	19 42 14,49	2,927	0,001	81 35 10,76	9,067	0,384
β Aquilæ	19 46 42,82	2,948	0,001	84 1 21,76	8,577	0,369

Catalogue continued.

	AR. 1825.	Ann. Var. 1824.	Secular Var.	N. P. D. 1825.	Ann. Var. 1824.	Secular Var.
	h ′ ″	″	″	° ′ ″	″	″
1 α Capricorni	20 7 56,33	3,331	0,008	103 2 28,35	— 10,659	— 0,411
2 α Capricorni	20 8 20,14	3,335	— 0,008	103 4 45,61	10,694	0,411
α Cygni	20 35 27,90	2,038	+ 0,002	45 20 26,76	12,599	0,227
α Cephei	21 14 23,68	1,440	— 0,006	28 9 12,63	15,045	0,131
β Cephei	21 26 21,92	0,812	0,032	20 12 23,06	15,660	0,064
α Aquarii	21 56 47,45	3,083	0,004	91 9 55,76	17,258	0,227
Fomalhaut	22 47 57,63	3,338	— 0,022			
α Pegasi	22 56 2,84	2,979	+ 0,005	75 44 2,72	19,292	— 0,116
α Andromedæ	23 59 21,43	+ 3,076	+ 0,018	61 52 32,10	19,932	+ 0,904

Mean error of the catalogue in AR *in space*, by observations of the Sun in Spring and Autumn, with the eight feet astronomical circle.

		Days Obsr.	
Autumn,	1822	10	$+0{,}40'' \; +0{,}04'' \; dL \; -0{,}06'' \; dr \; -0{,}07'' \; dO$
Spring,	1823	11	
Autumn,	1823	18	$-0{,}62 \; -0{,}11 \; dL \; +0{,}10 \; dr \; +0{,}14 \; dO$
Spring,	1824	18	
Autumn,	1824	16	$+0{,}34 \; +0{,}04 \; dL \; +0{,}10 \; dr \; -0{,}16 \; dO.$
Spring,	1825	18	

Mean error of Catalogue $= +0{,}04 \; -0{,}01 \; dL \; +0{,}05 \; dr \; -0{,}03 \; dO.$

Where dL = error in latitude, dr = error in constant of refraction, dO = error in obliquity of ecliptic.

The small coefficient of dr shows that the error arising from the errors of division must be absolutely insensible.

	Dr. Maskelyne AR. 1805.	Cat. 1825 reduced to 1805.	Diff.	Piazzi N. P. D. 1800.	Cat. 1825 reduced to 1800.	Diff.
	h ′ ″	″	″	° ′ ″	″	′
γ Pegasi	0 3 12,35	12,39	— 0,04	75 55 43,4	42,15	+ 1,25
α Cassiopeæ				34 33 42,4	41,11	+ 1,29
Polaris				1 45 35,7		
α Arietis	1 56 12,38	12,48	— 0,10	67 29 23,5	23,93	— 0,43
α Ceti	2 52 5,74	5,88	— 0,14	86 42 11,2	11,05	+ 0,15
α Persei				40 51 47,0	47,55	— 0,55
Aldebaran	4 24 44,58	44,60	— 0,02	73 54 18,0	19,84	— 1,84
Capella	5 2 18,15	18,13	+ 0,02	44 13 22,5	20,84	+ 1,66
Rigel	5 5 10,13	10,21	— 0,08	98 26 36,4	36,60	— 0,20
β Tauri	5 13 58,37	58,37		61 34 34,5	33,81	+ 0,69
α Orionis	5 44 36,94	36,97	— 0,03	82 38 35,0	34,65	+ 0,35
Sirius	6 36 33,07	32,90	+ 0,17	106 27 6,2	6,85	— 0,65
Castor	7 22 8,02	8,11	— 0,09	57 41 15,0	15,01	— 0,01
Procyon	7 29 5,10	5,16	— 0,06	84 16 21,5	23,95	— 2,45
Pollux	7 33 21,78	21,86	— 0,08	61 30 13,2	12,75	+ 0,45
α Hydra	9 18 0,07	0,19	— 0,12	97 47 54,5	54,36	+ 0,14
Regulus	9 57 58,26	58,31	— 0,05	77 3 38,0	39,62	— 1,62
β Ursæ Maj.				32 32 55,5	56,53	— 1,03
α Ursæ Maj.				27 10 21,6	20,97	+ 0,63
β Leonis	11 39 6,13	6,15	— 0,02	74 18 35,3	36,84	— 1,54
γ Ursæ Maj.				35 11 37,0	35,16	+ 1,84
ε ———				32 57 7,5	5,00	+ 2,50
Spica Virginis	13 14 56,10	56,09	+ 0,01	100 6 44,0	48,04	— 1,04
ζ Ursæ Maj.				34 1 34,2	34,13	+ 0,07
η				39 41 0,8	1,67	— 0,87
Arcturus	14 6 46,17	46,17		69 46 11,7	12,61	— 0,91
1 } α Libra	14 39 55,37	55,30	+ 0,07			
2 } α Libra	14 40 6,68	6,65	+ 0,03	105 12 4,0	5,12	— 1,12
β Ursæ Min.				15 1 39,6	37,17	+ 2,43
α Cor. bor.	15 26 25,98	26,00	— 0,02	62 36 12,0	13,48	— 1,48
α Serpentis	15 34 40,15	40,17	— 0,02	82 56 6,3	6,07	+ 0,23
Antares	16 17 28,11	28,19	— 0,08	115 58 26,0	25,98	+ 0,02
α Herculis	17 5 45,57	45,59	— 0,02	75 22 12,3	14,65	— 2,35
α Ophinchi	17 25 53,12	53,24	— 0,12	77 16 57,0	58,92	— 1,92
γ Draconis				38 28 55,5	54,09	+ 1,41
α Lyræ	18 30 20,17	20,17		51 23 39,2	39,19	+ 0,01
γ } Aquilæ	19 36 59,20	59,16	+ 0,04	79 51 48,6	48,81	— 0,21
α } Aquilæ	19 41 15,90	15,95	— 0,05	81 38 54,8	56,28	— 1,48
β } Aquilæ	19 45 43,90	43,86	+ 0,04	84 4 54,8	55,08	— 0,29
1 } α Cap. corni	20 6 49,61	49,69	— 0,08	103 6 51,5	53,60	— 2,10
2 } α Cap. corni	20 7 13,41	13,42	— 0,01	103 9 10,2	11,73	— 1,53

	Dr. Maskelyne AR. 1805.	Cat. 1825 reduced to 1805.	Diff.	Piazzi N. P. D. 1880.	Cat. 1825 reduced to 1800.	Diff.
	h ′ ″	″	″	° ′ ″	″	″
α Cygni	20 34 47,05	47,14	— 0,09	45 25 40,2	41,06	— 0,86
α Cephei				28 15 31,2	28,35	+ 2,85
β Cephei				20 18 57,2	54,36	+ 2,84
α Aquarii	21 55 45,69	45,79	— 0,10	91 17 6,1	6,54	— 0,44
Fomalhaut	22 46 50,68	50,83	— 0,15			
α Pegasi	22 55 3,20	3,26	— 0,06	75 52 2,9	4,67	— 1,77
α Andromedæ	23 58 19,85	19,95	— 0,10	62 0 51,0	50,40	+ 0,60

PROPER MOTIONS.

	R. A. in space annual.	N. P. D. annual	quantity in 66 years,	and direction.
	″	″	″	° ′
γ Pegasi	+ 0,009	+ 0,027	1,87	S 17 54 E
α Cassiopeæ	+ 0,075	+ 0,068	5,29	S 31 56 E
α Arietis	+ 0,170	+ 0,165	15,03	S 43 34 E
α Ceti	— 0,054	+ 0,123	8,86	S 23 40 W
α Persei	— 0,029	+ 0,061	4,22	S 17 15 W
Aldebaran	+ 0,027	+ 0,170	11,35	S 8 40 E
Capella	+ 0,049	+ 0,418	27,68	S 4 40 E
Rigel	+ 0,001	+ 0,011	0,73	S 5 8 E
β Tauri	+ 0,014	+ 0,192	12,70	S 3 40 E
α Orionis	+ 0,007	— 0,012	0,91	N 30 3 E
Sirius	— 0,538	+ 1,201	86,27	S 23 15 W
Castor	— 0,220	+ 0,033	12,50	S 79 56 W
Procyon	— 0,707	+ 1,010	81,23	S 34 51 W
Pollux	— 0,768	+ 0,023	44,61	S 88 3 W
α Hydræ	— 0,036	— 0,107	7,44	N 18 26 E
Regulus	— 0,310	— 0,074	20,54	N 76 15 W
α Ursæ Maj.	— 0,310	+ 0,033	9,63	S 76 56 W
β Leonis	— 0,557	+ 0,019	35,34	S 87 58 W
γ Ursæ Maj.	+ 0,150	— 0,059	6,92	N 55 46 E
ε ——	+ 0,162	— 0,005	5,85	N 86 46 E
ζ ——	+ 0,265	— 0,035	10,09	N 76 46 E
Spica-Virginis	— 0,085	— 0,034	5,96	N 67 53 W
η Ursæ Maj.	— 0,157	— 0,037	7,07	N 69 47 W
Arcturus	— 1,206	+ 1,902	146,10	S 30 46 W

PROPER MOTIONS.

	R. A. in space annual.	N. P. D. annual	quantity in 66 years,	and direction.
	"	"	"	°
2 α Libræ	— 0,108	— 0,018	6,98	N 80 12 W
β Ursæ Min.	+ 0,002	+ 0,020	1,32	S 1 30 E
α Cor. bor.	+ 0,126	0,000	7,39	90 0 E
α Serpentis	+ 0,144	— 0,129	12,71	N 47 56 E
Antares	— 0,044	— 0,049	4,15	N 38 54 W
α Herculis	— 0,021	— 0,085	5,77	N 13 27 W
α Ophinchi	+ 0,070	+ 0,156	11,24	S 23 28 E
γ Draconis	+ 0,080	+ 0,021	3,57	S 67 8 E
α Lyræ	+ 0,296	— 0,301	25,05	N 37 32 E
γ Aquilæ	+ 0,031	— 0,020	2,41	N 56 45 E
α Aquilæ	+ 0,530	— 0,395	43,32	N 53 0 E
β Aquilæ	+ 0,038	+ 0,446	29,54	S 4 50 E
1 α Capricorni	— 0,040	— 0,012	2,69	N 72 53 W
2 α Capricorni	+ 0,015	— 0,018	1,53	N 39 4 E
α Cygni	— 0,003	+ 0,016	1,06	S 7 36 W
α Cephei	+ 0,384	+ 0,035	12,18	S 79 4 E
β ——	+ 0,081	+ 0,096	6,60	S 16 14 E
α Aquarii	— 0,032	+ 0,011	2,23	S 71 1 W
α Pegasi	+ 0,047	+ 0,038	4,07	S 51 55 E
α Andromedæ	+ 0,128	+ 0,176	13,80	S 32 40 E

*Annual precession determined by several stars near the equinoctial colure, and the proper motion of the Pole Star in N. P. D. deduced from each determination.**

	Proper motion in N. P. D. in 66 years by α Cygni and α Orionis.	Proper motion in N.P.D. in 66 years by α Cygni and Rigel.	$\frac{1}{66}$ P. m. in N.P.D.	$\frac{1}{66}$ observed motion in N. P. D. in 66 years.	Coeff. luni-solar precess. in N.P.D.	Ann. prec. in long. 1788.	Pr. mot. Polaris in N. P. D. in 66 years.
	"	"	"	"	"	"	"
γ Pegasi	+ 2,18	+ 1,88	+ 0,030	— 20,082	20,113	50,507	+ 3,6
α Arietis	+ 12,05	+ 12,23	+ 0,183	— 17,450	20,125	50,538	4,5
Regulus	— 4,72	— 4,62	— 0,071	+ 17,216	20,119	50,522	4,0
α Ursæ Maj.	+ 2,75	+ 3,27	+ 0,046	+ 19,228	20,102	50,480	2,8
β Leonis	+ 1,34	+ 1,60	+ 0,022	+ 20,0 9	20,108	50,495	3,3
γ Ursæ Maj.	— 3,60	— 2,64	— 0,047	+ 19,994	23,101	50,474	2,6
ε	— 0,22	+ 0,82	+ 0,004	+ 19,723	20,110	50,500	3,4
Spica Virg.	— 2,57	— 2,49	— 0,038	+ 19,033	20,110	50,500	3,4
η Ursæ Maj.	— 2,54	— 1,35	— 0,029	+ 18,217	20,097	50,468	2,5
Arcturus	+ 126,36	+ 125,82	+ 1,910	+ 19,045	20,096	50,465	2,4
α Aquarii	+ 0,16	+ 0,00	+ 0,001	— 17,181	20,105	50,490	3,1
α Pegasi	+ 2,36	+ 2,28	+ 0,005	— 19,251	20,094	50,460	2,3
α Andromedæ	+ 11,57	+ 11,69	+ 0,176	— 19,933	20,110	50,501	3,4
				Mean	20,107	50,492	+ 3,18

* This table should have preceded the Catalogue in right ascension.